Review Article

Methods for tissue perfusion assessment after Dellon decompression of tarsal tunnels in diabetic neuropathy: key to effective management—a narrative review

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Background and Objective: Diabetic neuropathy significantly elevates the risk of foot ulceration and lower-limb amputation, underscoring the need for precise assessment of tissue perfusion to optimize management. This narrative review explores the intricate relationship between sympathetic nerves and tissue perfusion in diabetic neuropathy, highlighting the important role of autonomic neuropathy in blood flow dynamics and subsequent compromises in tissue perfusion. The consequences extend to the development of diabetic peripheral neuropathy and related foot complications. By analyzing both non-invasive diagnostic methods and surgical interventions, such as tarsal tunnel decompression, the paper seeks to highlight their effectiveness in improving tissue perfusion, preventing ulcers, and reducing the risk of amputations in patients with diabetic peripheral neuropathy.

Methods: We reviewed current literature on both non-invasive diagnostic tools and surgical techniques for assessing and improving tissue perfusion in diabetic neuropathy. Methods discussed include transcutaneous oxygen pressure ($TcPO_2$), Doppler ultrasound, Tissue-Muscle Perfusion Scintigraphy with ^{99m}Tc-MIBI, and the SPY Laser Angiographic System.

Key Content and Findings: Emphasizing the critical importance of surgical interventions, such as tarsal tunnel decompression and neurolysis of the posterior tibial nerve, the article underscores their efficacy in enhancing tissue perfusion and preventing ulcers and amputations. Additionally, it addresses the significance of precise blood flow measurement and timely intervention in the management of diabetic neuropathy and foot ulcers. The non-invasive techniques for assessing tissue perfusion and blood flow in diabetic neuropathy such as $TcPO_2$, Doppler ultrasound and Tissue-Muscle Perfusion Scintigraphy with ^{99m}Tc-MIBI are explained. Also, this review introduces the SPY Laser Angiographic System, which employs near-infrared fluorescence imaging to assess blood flow and perfusion in tissues. This advanced tool generates real-time

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microvascular blood flow images and proves instrumental in diagnosing and monitoring diabetic foot ulcers.
Conclusions: In conclusion, surgical interventions, both vascular and peripheral nerve are pivotal for optimizing patient care. Early identification of foot ulcers and peripheral arterial disease is imperative, and an understanding of blood flow dynamics, combined with effective surgical techniques, constitutes key elements in managing diabetic neuropathy, healing and preventing ulcers, and limb salvage.

Keywords: Diabetic neuropathy; diabetic foot ulcers (DFU); tissue perfusion; blood flow assessment

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Introduction

Effective management of diabetic neuropathy and its complications requires a comprehensive understanding of both vascular and neural functions in the lower extremities. Tissue perfusion plays a critical role in preventing foot ulcers and subsequent amputations, particularly in diabetic patients suffering from neuropathy. Recent advancements in imaging and diagnostic tools offer new possibilities for assessing tissue perfusion in patients with diabetic neuropathy. This paper provides a narrative review of current methods used to evaluate tissue perfusion, exploring their relevance and applicability in the context of Dellon decompression as a key therapeutic intervention.

Diabetic neuropathy is a complication of diabetes, and the cause of the development of diabetic foot ulcers (DFU) that can lead to serious complications such as amputations of the lower limb (1). The pathogenesis of diabetic peripheral neuropathy involves complex pathophysiological mechanisms involving various metabolic disorders and oxidative stress, which ultimately leads to a cascade of harmful consequences (2-4). Long-term elevated blood glucose levels disrupt the normal physiology of the small blood vessels responsible for supplying oxygen and nutrients to the nerves. Inflammation, along with disturbances in nerve signalling, further increases the progression of diabetic neuropathy (5). Loss of sensation in the feet caused by neuropathy makes people with diabetes unable to detect minor injuries or wounds on their feet. This sensory deficit results in the insidious development of undetected and untreated injuries, which greatly increases the risk of foot ulceration (6). Neuropathy, through loss of sympathetic function, compromises soft tissue perfusion specifically epidermal capillaries. The imposition of external mechanical factors, such as increased plantar pressures, causes a complex interplay of risk factors that ultimately culminates with the appearance of a DFU and limb loss (6). The combination of internal and external factors contributes significantly to the genesis of these complications, and thus has a great impact on the health and overall quality of life of the patients with diabetic neuropathy (7).

Angiosomes of the posterior tibial artery

The posterior tibial artery supplies the medial part of the lower leg. In the area of the medial malleolus, the posterior medial malleolar branch emerges from the posterior tibial artery, which joins the anterior medial malleolar branch of the anterior tibial artery, which represents an important interconnection between the posterior tibial artery and the anterior tibial artery.

The medial calcaneal artery is a branch of the posterior tibial artery and gives the vascularization to the heel. The border of the angiosome of the medial calcaneal artery includes the medial and plantar part of the heel. The plantar artery gives off two main branches: superficial and deep branches. Perforating branches supply the medial part of the foot. The lateral plantar artery enters the midfoot, and anastomoses directly with the dorsalis pedis artery in the proximal first interspace, ensuring that flow is maintained to the entire foot if the proximal dorsalis pedis or lateral plantar artery becomes occluded (8-10).

The innervation of the foot

The complex innervation of the foot and its implications for diabetic neuropathy are key to understanding the complexity of diabetic foot complications. The medial plantar nerve, lateral plantar nerve, and calcaneal nerve are key players in the development and management of complications of the diabetic foot that relate to the sensory,

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motor functions as well as the autonomic and sympathetic functions of the foot. Understanding their specific functions and distributions is essential to identify potential areas of vulnerability in diabetic foot complications.

A deeper understanding of the interactions between the tibial nerve, its branches, and the sympathetic nerve fibers between the posterior tibial artery and the posterior tibial nerve serves as a basis for precision in clinical assessment and management. This evidence can lead to more effective and personalized care for people with diabetic foot conditions, ultimately improving outcomes and overall quality of life for those affected by diabetic foot conditions (11-15).

The posterior tibial nerve plays a critical role in maintaining the health and function of the foot, with sympathetic interconnections with the posterior tibial artery and its branches, which regulate blood flow and vascular tone in the foot. The nerve also provides sensory innervation to the foot, essential for detecting pain, temperature, and pressure changes, which are essential for maintaining proper gait, balance, and disturbances of cutaneous microcirculatory responses in diabetic foot (16-19).

Sympathetic nerve-tissue perfusion interaction in diabetic neuropathy: an exploration of sympathetic nerves and tissue perfusion in the foot

Diabetic neuropathy is a common and complication of diabetes mellitus, affecting various sensory and motor functions and sympathetic afferent and efferent messaging and the Tehrani/Jorneskog epidermal chronic capillary ischemia (CCI), arterio-venous (A-V) shunting and 'vascular capture' in dermal reticular layer. One of the critical factors contributing to its pathogenesis is the intricate relationship between sympathetic nerves and tissue perfusion in the foot. The sympathetic nervous system plays a vital role in regulating blood flow through its innervation of the microvasculature in the foot. These nerves govern the constriction and dilation of blood vessels, thereby controlling the flow of blood to tissues. However, in patients with diabetes and accompanying autonomic neuropathy, the sympathetic innervation of the microvasculature in the foot can become compromised, leading to imbalanced blood flow dynamics and reduced tissue perfusion (20,21).

Autonomic neuropathy, often observed in patients with peripheral sensorimotor neuropathy, plays a significant role in disrupting proper blood flow in the diabetic foot. Diabetic patients with impaired adaptive responses are more susceptible to extensive tissue injury and have a diminished ability to increase perfusion, reduce tissue harm, and repair tissue damage (22). Moreover, autonomic neuropathy contributes to reduced vascular sympathetic innervation and the development of arterio-venous shunting in the foot. These arterio-venous shunts, which are innervated by sympathetic nerves, may open up or dilate due to denervation associated with autonomic neuropathy in diabetes, causing reduction in epidermal subpapillary capillary flow between the nutritional capillaries and subpapillary vessels.

Impact on tissue perfusion

The resulting imbalance in blood flow can lead to a decrease in perfusion to the capillaries, ultimately contributing to the development of diabetic peripheral neuropathy and other foot complications especially DFU. It is essential to address this disruption in tissue perfusion to prevent the progression of diabetic neuropathy and its associated consequences (23).

Tarsal tunnel decompression and neurolysis of the posterior tibial nerve have emerged as promising approaches (*Figure 1*). Blount *et al.* (24) conducted a study investigating the effects of these procedures on tissue perfusion in patients with diabetic neuropathy. Their findings demonstrated a significant increase in blood flow to the foot after tarsal tunnel decompression and neurolysis of the posterior tibial nerve, indicating improved tissue perfusion.

Additionally, another study conducted by Aszmann *et al.* (25) showed that decompression of the tibial nerve in diabetic neuropathic patients led to sensory recovery and prevented subsequent ulcerations and amputations.

These findings underscore the value of restoring normal sympathetic function through surgical interventions, such as tarsal tunnel decompression and posterior tibial nerve neurolysis, to improve tissue perfusion in the diabetic foot. Relief of pain, restoration of sensation, and increased blood flow to the foot have been observed as a result of these interventions. This emphasizes the pivotal role of sympathetic nerves in regulating tissue perfusion and highlights the potential benefits of addressing neuropathic complications through surgical means (26-33).

Microcirculatory disturbances

Diabetic neuropathy represents a complex complication stemming from a myriad of metabolic and microvascular aberrations. Extensive research underscores the impaired capillary blood supply to nerves caused by augmented arteriovenous shunting within the microcirculation.

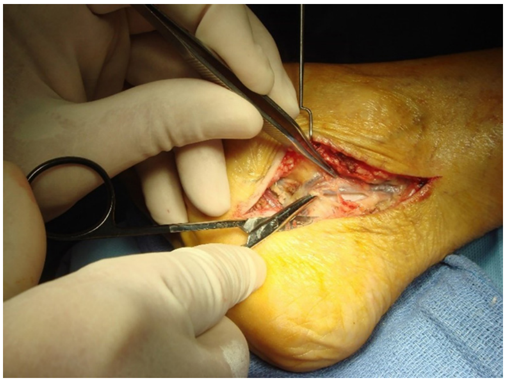

Figure 1 The sympathetic innervation of the tibial artery enters by these branches from the tibial nerve, shown beneath the scissors, in patient having tarsal tunnel decompression. Photo courtesy of A Lee Dellon, MD, PhD.

This phenomenon is intrinsically associated with the numerous arteriovenous shunts embedded within the skin's microcirculation, primarily under the influence of the sympathetic nervous system. The consequences of impaired blood flow and elevated blood glucose levels on the capillaries, which supply oxygen and nutrients to the nerves, are profound. Patients enduring longstanding diabetic neuropathy exhibit compromised regulatory mechanisms and microcirculatory dysfunction, thereby perpetuating the deleterious effects on blood flow to the nerves within the diabetic foot (34).

Vascular surgical interventions can significantly impact blood flow as part of the healing process of DFU. Arora *et al.* (35) have documented improved microcirculation post-surgery, including the restoration of normal skin blood flow and correction of abnormal preoperative plethysmographic values. This demonstrates the dynamic nature of blood flow in response to surgical procedures (36-38).

The relationship between blood flow, DFU, and surgery has critical clinical implications. Delayed diabetic ulcer healing can be linked to the pathophysiology of hypertension, small blood vessel narrowing, and increased resistance to blood flow. Local factors such as arteriosclerosis, media layer hyperplasia, elastic lamina alteration, and thrombosis play vital roles in impeding the healing process (39). Thus, accurate measurement of increased blood flow in patients with ulcers or post-surgery necessitates appropriate timing.

The aim of this narrative review is to elaborate the different non-invasive vascular diagnostic techniques which can be employed for identifying patients with diabetic neuropathy, minimizing the risk of complications. Reduced healing potential of DFU as result of low perfusion underscores the importance of early intervention and monitoring of perfusion in patients with diabetic neuropathy (40). We present this article in accordance with the Narrative Review reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-24-822/rc).

Methods

The literature selection process was done searching PubMed, Scopus, and Google Scholar databases. To identify relevant studies we used the search terms: "diabetic neuropathy", "tissue perfusion", "blood flow assessment", "foot ulcers", and "surgical interventions". For the review we included clinical trials, systematic reviews, meta-analyses, and case studies published in the last 40 years that focus on methods for assessing tissue perfusion, particularly in cases of diabetic neuropathy. Studies focused only on animal models or those with sample sizes too small to yield statistically significant results were excluded. Initially, we reviewed titles and abstracts to identify relevant articles, followed by a full-text review to ensure they aligned with the scope of our review (*Table 1*). All authors are actively involved in the clinical management and research of diabetic neuropathy and its complications. Most are practicing plastic surgeons with extensive experience in surgical interventions, including tarsal tunnels decompression, while others have been involved in the use of diagnostic tools during the perioperative period for the assessment of tissue perfusion and follow-up care.

Transcutaneous oxygen pressure ($TcPO_2$) assessment in diabetic foot perfusion

$TcPO_2$ has emerged as a diagnostic instrument for evaluating foot perfusion in patients with diabetic neuropathy. This technique has gained widespread acceptance due to its non-invasive nature and its capacity to provide essential information concerning blood flow, oxygen delivery, and tissue oxygenation status. $TcPO_2$ has proven particularly valuable in assessing skin perfusion and tissue oxygenation status in patients with diabetes, especially those afflicted by peripheral neuropathy.

Decreased cutaneous micro-circulatory responses to local heating often result in lower $TcPO_2$ values in

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Table 1 The search strategy summary

Items	Specification
Date of search	20/10/2023–16/12/2023
Databases and other sources searched	PubMed, Scopus, and Google Scholar databases
Search terms used	"diabetic neuropathy", "tissue perfusion", "blood flow assessment", "foot ulcers", and "surgical interventions"
Timeframe	40 years (1983–2023)
Inclusion and exclusion criteria	Included clinical trials, systematic reviews, meta-analyses, and case studies. Exclusion criteria: animal models or those with sample sizes too small
Selection process	The selection process was conducted independently by four authors (S.P., A.L.D., D.S.N., S.T.). Any disagreements were resolved through discussion, and consensus was achieved with the involvement of a fifth reviewer when necessary

diabetic patients compared to non-diabetic controls, indicative of poor healing outcomes. Based on existing research, a $TcPO_2$ level below 30 mmHg emerges as a robust predictor of unfavorable healing outcomes in DFU and lower limb amputations. This non-invasive modality assumes paramount importance in the evaluation of skin perfusion and tissue oxygenation status in diabetic patients, particularly those with peripheral neuropathy. The attenuated cutaneous micro-circulatory responses to local heating commonly observed in this patient population frequently result in diminished $TcPO_2$ values, which are strongly associated with suboptimal healing prospects (41).

In addition to $TcPO_2$, the assessment of skin perfusion pressure and other non-invasive techniques are also recommended for a comprehensive evaluation of healing potential and determination of amputation levels in diabetic patients with foot ulcers. These complementary methods provide valuable information that augments the diagnostic utility of $TcPO_2$ assessment. It is imperative to recognize that $TcPO_2$ readings can be influenced by a multitude of factors, including the presence of neuropathy, infection, and edema in the foot. These confounding variables must be considered when interpreting $TcPO_2$ results to ensure accurate assessment of tissue perfusion and oxygenation status.

In conclusion, $TcPO_2$ assessment represents a valuable method, offering critical insights into tissue perfusion and oxygenation status. The consistent evidence demonstrating the association between $TcPO_2$ levels below 30 mmHg and poor healing outcomes, as well as the increased risk of lower limb amputation in diabetic patients, underscores its clinical relevance. Moreover, this non-invasive methodology provides valuable information regarding skin perfusion and microcirculatory responses, thereby facilitating treatment decision-making and prognostication in the management of DFU (42-45).

Doppler ultrasonography for the evaluation of blood flow in diabetic neuropathy

Doppler ultrasound is a non-invasive diagnostic technique that plays a pivotal role in evaluating blood flow and velocity in the posterior tibial artery and its plantar branches in patients with diabetes.

Doppler ultrasound relies on the Doppler effect, which is the change in frequency of sound waves as they reflect off moving objects, such as blood cells. When sound waves (ultrasound) are directed at a moving blood vessel, they are reflected back to the transducer with a frequency shift proportional to the velocity of the blood flow. By analyzing these frequency shifts, Doppler ultrasound can provide valuable information about blood flow and velocity. The posterior tibial artery and its plantar branches are crucial vessels responsible for supplying blood to the feet. In diabetic patients, these arteries can become compromised due to atherosclerosis, neuropathy-induced changes, or a combination of both (46,47). Doppler ultrasound is the method for evaluating blood flow and velocity in these arteries. It allows for both qualitative and quantitative assessment of blood flow in the posterior tibial artery and its plantar branches.

A continuous wave Doppler mode can detect the characteristic "whooshing" or "swishing" sounds of blood flow, indicating patency. In addition to qualitative

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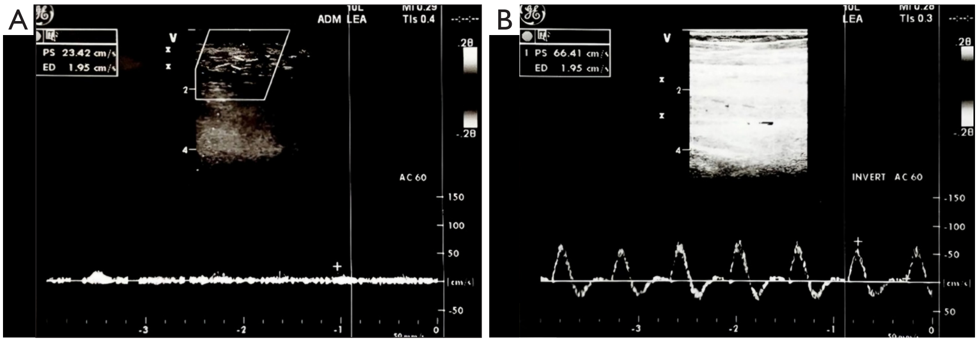

Figure 2 Doppler ultrasound of posterior tibial artery (A) before and (B) after Dellon Tarsal Tunnel decompression in patient with diabetic neuropathy.

assessment, Doppler ultrasound allows for quantitative measurements of blood velocity. Peak systolic velocity (PSV) and end-diastolic velocity (EDV) are key parameters evaluated (*Figure 2*). In diabetic patients, reduced PSV and elevated EDV can be indicative of compromised blood flow. Moreover, the calculation of the ankle-brachial index (ABI) using Doppler measurements helps assess the severity of arterial disease and predict the risk of ulceration (48,49).

Doppler ultrasound offers several advantages for assessing blood flow in diabetic patients with neuropathy and foot ulcers (50). Unlike traditional angiography, Doppler ultrasound is non-invasive and does not require contrast agents or arterial punctures, also provides real-time images and measurements, enabling clinicians to assess blood flow dynamically and make immediate clinical decisions.

By identifying reduced blood flow and velocity in the posterior tibial artery and plantar branches, Doppler ultrasound allows for early detection, potentially preventing the development of DFU. Furthermore, Doppler ultrasound can track changes in blood flow and velocity over time, helping in evaluation of the effectiveness of interventions such as revascularization, nerve decompression and wound care. In diabetic neuropathy and DFU management, Doppler ultrasound plays a pivotal role in assessing blood flow and velocity in the posterior tibial artery and its plantar branches. This non-invasive technique provides both qualitative and quantitative information, aiding in early detection, treatment planning, and ongoing monitoring. Doppler ultrasound is a promising diagnostic tool to prevent and manage the devastating complications associated with diabetes mellitus (49).

Assessing foot perfusion in diabetic neuropathy with ^{99m}Tc-MIBI scintigraphy

Tissue-Perfusion Scintigraphy with ^{99m}Tc-MIBI is a diagnostic technique that shows promise in the early detection of perfusion defects in diabetic patients, thereby enabling timely intervention and the prevention of devastating consequences. The technique involves the intravenous administration of ^{99m}Tc-MIBI, a radiopharmaceutical agent that can assess microvascular foot perfusion and identify regional perfusion. Once injected, the agent accumulates in metabolically active muscle tissue, making it a reliable marker for tissue perfusion. The region of interest (the patient's foot) is positioned under a gamma camera, and scintigraphic images are obtained with radioactive tracer distribution in the tissue (*Figure 3*). The advantages of tissue-muscle perfusion scintigraphy with ^{99m}Tc-MIBI are manifold. It is a non-invasive method that can identify subtle changes that may not be apparent through clinical examination alone, thus eliminating the need for more invasive procedures and providing quantitative data about tissue perfusion. Early identification of perfusion defects can prompt targeted interventions, such as revascularization procedures, wound care, and optimized glycemic control. Furthermore, this technique is particularly beneficial for identifying "at-risk" patients who may not yet exhibit clinical symptoms. By detecting perfusion defects before the development of ulcers, preventive procedures can be employed to avoid severe complications. Regular monitoring with this method can also help track the effectiveness of treatment strategies overtime. In conclusion, tissue perfusion scintigraphy with

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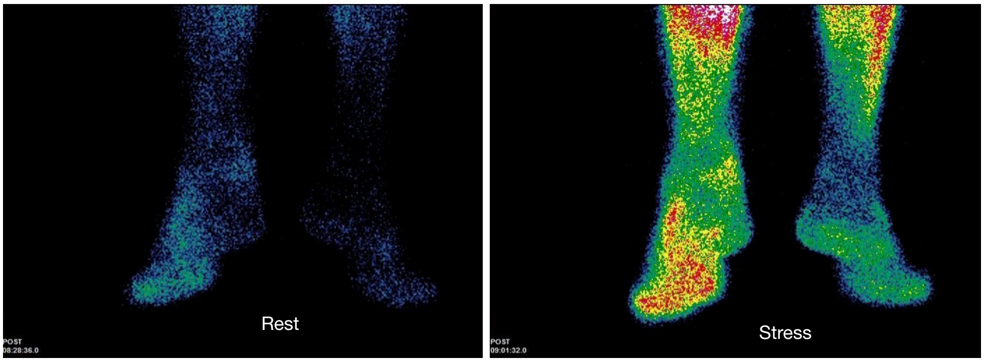

Figure 3 Scintigraphic finding of a patient with diabetic neuropathy with greater tissue perfusion in the left foot in both studies—"rest" and "stress", after Dellon four medial ankle tunnels decompression.

^{99m}Tc-MIBI is a promising diagnostic tool for the early detection of tissue perfusion deficits in diabetic patients with neuropathy. Timely identification of perfusion issues can significantly reduce the risk of DFU and amputations, improving the overall quality of life for individuals living with diabetes. Further research and clinical studies are needed to validate and optimize this technique, but its potential to revolutionize diabetic care is evident (51).

Advancing perfusion assessment in diabetic neuropathy and DFU with SPY technique

The SPY Laser Angiographic System represents a significant advancement in the assessment and management of DFU. This review will explore the technical aspects of the SPY system and its practical application in evaluating perfusion in DFU. The SPY Laser Angiographic System utilizes indocyanine green (ICG) dye in conjunction with near-infrared fluorescence imaging to assess blood flow and perfusion in tissues. The procedure begins with the intravenous injection of ICG, a fluorescent dye that binds to plasma proteins and remains intravascular. When exposed to near-infrared light, ICG emits fluorescence, allowing visualization of blood flow in real-time (52,53).

The SPY system's imaging technology employs a laser source that emits near-infrared light. This light penetrates the tissue and causes the ICG dye to fluoresce. The emitted light is captured by the system's camera, and the data are processed to produce detailed images of blood flow in the tissues under examination. One of the key technical advantages of the SPY system is its ability to provide high-resolution, real-time images of microvascular blood flow. This is critical in assessing the perfusion of DFU, where compromised blood flow is a major concern. The system's sensitivity allows for the detection of even subtle changes in perfusion, which can be vital in early intervention and treatment planning (54).

The SPY system plays a crucial role in this assessment. By visualizing blood flow in the affected area, the extent of perfusion impairment can be determined. This information is vital in making clinical decisions, such as the need for revascularization procedures, the viability of tissue for debridement, and the selection of appropriate wound therapies.

In addition, the SPY system's ability to provide real-time imaging is particularly advantageous in the surgical setting. During debridement or revascularization procedures, the system can be used intraoperatively to assess and ensure adequate perfusion to the remaining tissues. This can significantly reduce the risk of postoperative complications related to inadequate blood supply.

The SPY Laser Angiographic System is a revolutionary tool in the management of DFU. Its advanced imaging technology provides critical insights into tissue perfusion, aiding in the diagnosis, treatment planning, and monitoring of these complex wounds. By enabling more precise assessments, the SPY system has the potential to improve outcomes for patients suffering from DFU, reducing the risk of complications and enhancing the quality of life (55).

However, the SPY system is not without its limitations. The initial cost of acquiring the equipment can be substantial, posing a financial challenge for some healthcare facilities, especially in resource-limited settings. Additionally, the technology requires specialized training for healthcare professionals, which could limit its widespread adoption and accessibility. Another potential drawback is

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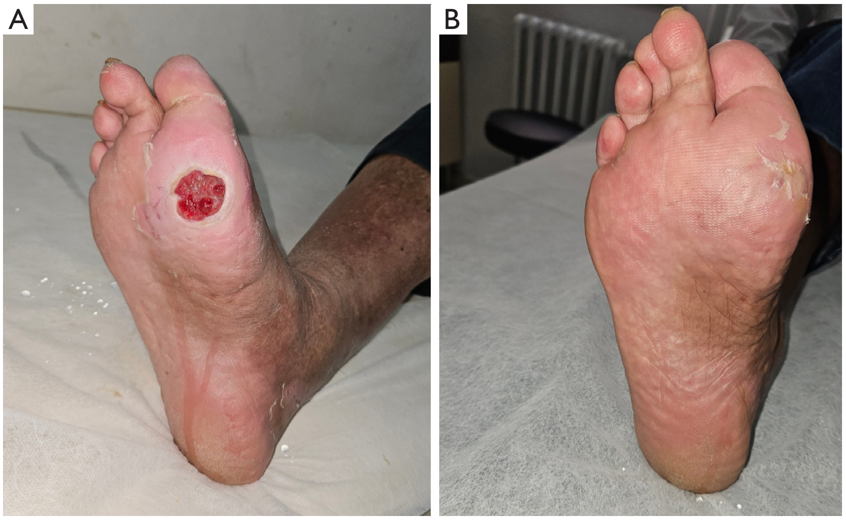

Figure 4 Comparison of pre- and postoperative condition in a neuropathic patient who underwent tarsal tunnels decompression surgery: (A) preoperative ulcer size, (B) postoperative photo showing completely healed ulcer.

the reliance on the specific dye used in the system, which might not be suitable for all patients, especially those with specific allergies or contraindications. Despite these challenges, the SPY Laser Angiographic System holds promise for enhancing the management of DFU, offering a blend of cutting-edge technology and patient-centered care (54,55).

Discussion

Diabetic neuropathy intimately is associated with compromised blood flow in the foot, precipitated by factors such as augmented arteriovenous shunting within the microcirculation and autonomic neuropathy. This compromised blood flow fosters reduced nutrient delivery to the tissues and amplifies the adverse effects of hyperglycemia and development of axonopathy. The influence of diabetic neuropathy on blood flow and nutrient supply to nerves and tissues is paramount. The synergy of diminished blood flow and elevated blood glucose levels assumes a pivotal role in exacerbating nerve damage and impairing microcirculation. The collective findings from diverse studies underscore the imperative nature of addressing these factors in the management of diabetic neuropathy. Furthermore, a complex approach that takes into account both nutritional aspects and microvascular disorders is indispensable in mitigating the progression of diabetic neuropathy. Focusing on interventions that not only improve blood flow and oxygenation but also accentuate the role of nutrition in facilitating nerve repair and regeneration is of paramount importance (56-58).

In the treatment strategy, the complex interplay between ulcer presence, surgical interventions, and their respective impacts on blood flow dynamics is a pivotal point. Additionally, the importance of early intervention and monitoring, particularly in patients with DFU highlighting the critical role of increased perfusion in the healing process (*Figure 4*) (59,60).

Conclusions

Both ulceration and surgery can increase blood flow due to the healing process. These findings emphasize the importance of assessing and monitoring blood flow in patients with ulcers, particularly those with DFU. Increased perfusion in regions of granulation is supportive of angiogenesis and plays a significant role in the healing process. Early identification of patients with foot ulcers, microcirculation deficit and peripheral arterial disease is critical, as these factors strongly influence healing outcomes. Our direct involvement in the surgical management and diagnostic evaluation of diabetic neuropathy has provided firsthand insights into the clinical efficacy of these techniques. This review is not only supported by the literature but is deeply informed by our real-world clinical outcomes. In our clinical practice, we have consistently seen improvements in tissue perfusion following tarsal tunnels decompression, corroborating the outcomes reported in recent studies.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-24-822/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All clinical procedures described in this study were performed in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this article and accompanying image. A copy of the written consent is available for review by the editorial office of this journal.

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